EV063793805US

JC05 Rec'd PCT/PTO 03 APR 2002

FORM PTO-1390 (Modified)
(REV 11-2000)

ADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
BKR-22202/01	
U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR	
10/089809	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB00/03845	9 October 2000	8 October 1999

TITLE OF INVENTION
AN OPTICAL SYSTEM

APPLICANT(S) FOR DO/EO/US
MILNER, Peter James

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Application Data Sheet
Postcard

25006
PATENT_TRADEMARK OFFICE

PCTUS1/REV03

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/089809	PCT/GB00/03845	BKR-22202/01

24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**
	Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$130.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	16 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**			☐	**$0.00**	
	TOTAL OF ABOVE CALCULATIONS =			**$1,020.00**	
☒	Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.			**$510.00**	
	SUBTOTAL =			**$510.00**	
	Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +			**$0.00**	
	TOTAL NATIONAL FEE =			**$510.00**	
☐	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			**$0.00**	
	TOTAL FEES ENCLOSED =			**$510.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$510.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **07-1180** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Douglas W. Sprinkle
Gifford, Krass, Groh, Sprinkle,
Anderson & Citkowski, P.C.
280 N. Old Woodward Ave., Suite 400
Birmingham, MI 48009

SIGNATURE

Douglas W. Sprinkle
NAME

27,394
REGISTRATION NUMBER

4/3/02
DATE

Attorney Docket No. BKR-22202/01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Peter James Milner

Serial No.:

Filed:

For: AN OPTICAL SYSTEM

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of this application, please amend the application as follows:

IN THE SPECIFICATION:

Please amend the paragraph beginning on line 27 of page 5 as follows:

In any of the above aspects or embodiments of the invention the reflectors or refractor elements may be convexly or concavely curved.

IN THE CLAIMS:

Please cancel claim 1.

Please amend claim 2 as follows:

2. (Amended) An optical system according to Claim 17, characterised in that at least one of the optical elements (23, 24) is a fresnel refractor.

Please amend claim 3 as follows:

3. (Amended) An optical system according to Claim 17, characterised in that there are three light-diverting optical elements.

Please amend claim 4 as follows:

4. (Amended) An optical system according to Claim 17, characterised in that the facets (30, 31) of one light-diverting optical element (23) are inclined with respect to the uninterrupted surface (29) of that element (23) at a different angle from that between the facets (23) of the other light-diverting optical element (24) and the uninterrupted surface (22) of that element (24).

Please amend claim 5 as follows:

5. (Amended) An optical system according to Claim 17, characterised in that the facets (30,31) of both or at least two of the light-diverting optical elements (23, 24) are inclined at the same angle with respect to the uninterrupted surface (22, 29) of the respective element (23, 24).

Please amend claim 6 as follows:

6. (Amended) An optical system according to Claim 17, characterised in that at least two optical elements (23, 24; 35, 36, 24) of different material from one another are positioned with their prismatic apex angles oriented oppositely from one another.

Please amend claim 8 as follows:

8. (Amended) An optical system according to Claim 17, characterised in that the prismatic apex angles of at least two of the said optical elements (35, 36) face in the same direction as one another.

Please amend claim 9 as follows:

9. (Amended) An optical system according to Claim 17, characterised in that the apex angles of the facets of two of the said optical elements (23, 24) interpenetrate one another.

Please amend claim 10 as follows:

10. (Amended) An optical system according to Claim 17, characterised at least two of the optical elements (23, 24; 35, 36, 24) are secured together by transparent adhesive.

Please amend claim 11 as follows:

11. (Amended) An optical system for extending the field of view of an observer through an opening, according to Claim 17, characterised in that the said two light-diverting optical elements (42, 43) co-operate to divert light incident thereon through the opening at an angle greater than a critical angle of incidence and to transmit therethrough undeviated light incident thereon through the opening at an angle less than the critical angle.

Please amend claim 15 as follows:

15. (Amended) An optical system according to Claim 12, characterised in that the said further reflector (39) is pivotally mounted to or adjacent one edge of the said first reflector (38).

Please amend claim 16 as follows:

16. (Amended) An optical system according to Claim 11, characterised in that the said light-diverting optical elements are convexly or concavely curved.

New claim 17 has been added as follows:

17. (New) An optical system (14) for enlarging the direct field of view of an observer through an opening (11), comprising at least two light-diverting optical components (23, 24; 35, 36, 24) positioned in the line of sight of an observer such that light incident thereon from a region outside the opening (11) which is obscured from the observer by an obstruction is diverted towards the observer by the successive light-diverting effects of the said optical components (23, 24; 35, 36, 24), characterised in that the said at least two light-diverting optical components (23, 24; 35, 36, 24) are optically transparent generally planar elements positioned in the region between the observer and the opening, and having inclined facets (30, 31) on one face thereof and substantially uninterrupted surfaces (22, 29) on the other face thereof, the substantially uninterrupted surfaces (22, 29) of the two elements (23, 24) being generally parallel to one another and the two transparent optical elements being made of different material such that chromatic aberrations introduced upon refraction of the light by one element are at least partially compensated upon refraction by another.

REMARKS

If the Examiner has any questions relating to the application, Applicant's attorney may be reached at (248) 647-6000.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with Markings to Show Changes Made."

Respectfully submitted,

Douglas W. Sprinkle, Reg. No. 27,394
Attorney for Applicant
Gifford, Krass, Groh, Sprinkle,
Anderson & Citkowski, P.C.
280 N. Old Woodward Ave., Suite 400
Birmingham, MI 48009-5394
(248) 647-6000

Date: 4/2/02

DWS/gs
GS-W:\Word Processing\dws\BKR22202-pre.doc

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph beginning on line 27 of page 5 has been amended as follows:

In any of the above aspects or embodiments of the invention the reflectors or refractor elements may be convexly or concavely curved.

IN THE CLAIMS:

Claim 1 has been cancelled.

Claim 2 has been amended as follows:

2. (Amended) An optical system according to Claim 17 [1], characterised in that at least one of the optical elements (23, 24) is a fresnel refractor.

Claim 3 has been amended as follows:

3. (Amended) An optical system according to Claim 17 [1 or Claim 2], characterised in that there are three light-diverting optical elements.

Claim 4 has been amended as follows:

4. (Amended) An optical system according to Claim 17 [any of Claims 1 to 3], characterised in that the facets (30, 31) of one light-diverting optical element (23) are inclined with respect to the uninterrupted surface (29) of that element (23) at a different angle from that between the facets (23) of the other light-diverting optical element (24) and the uninterrupted surface (22) of that element (24).

Claim 5 has been amended as follows:

5. (Amended) An optical system according to Claim 17 [any of Claims 1 to 3], characterised in that the facets (30,31) of both or at least two of the light-diverting optical elements (23, 24) are inclined at the same angle with respect to the uninterrupted surface (22, 29) of the respective element (23, 24).

Claim 6 has been amended as follows:

6. (Amended) An optical system according to Claim 17 [any preceding claim], characterised in that at least two optical elements (23, 24; 35, 36, 24) of different material from one another are positioned with their prismatic apex angles oriented oppositely from one another.

Claim 8 has been amended as follows:

8. (Amended) An optical system according to Claim 17 [any preceding claim], characterised in that the prismatic apex angles of at least two of the said optical elements (35, 36) face in the same direction as one another.

Claim 9 has been amended as follows:

9. (Amended) An optical system according to Claim 17 [any preceding claim], characterised in that the apex angles of the facets of two of the said optical elements (23, 24) interpenetrate one another.

Claim 10 has been amended as follows:

10. (Amended) An optical system according to Claim 17 [any preceding claim], characterised at least two of the optical elements (23, 24; 35, 36, 24) are secured together by transparent adhesive.

Claim 11 has been amended as follows:

11. (Amended) An optical system for extending the field of view of an observer through an opening, according to Claim 17 [any preceding claim], characterised in that the said two light-diverting optical elements (42, 43) co-operate to divert light incident thereon through the opening at an angle greater than a critical angle of incidence and to transmit therethrough undeviated light incident thereon through the opening at an angle less than the critical angle.

Claim 15 has been amended as follows:

15. (Amended) An optical system according to Claim 12 [any of Claims 12 to 14], characterised in that the said further reflector (39) is pivotally mounted to or adjacent one edge of the said first reflector (38).

Claim 16 has been amended as follows:

16. (Amended) An optical system according to Claim 11 [any preceding claim], characterised in that the said light-diverting optical elements are convexly or concavely curved.

New claim 17 has been added.

AN OPTICAL SYSTEM

The present invention relates generally to an optical system for diverting light to enable an observer to obtain an additional or different field of view from that which is normally available from the observation position.

In many circumstances an observer has a limited field of view because of restrictions in the position which can be adopted by the observer and/or by screening or shrouding necessarily present in the vicinity of the observer's position, for example in the form of machine parts or housings of the observation post. A machine operator, for example, may have a field of view through a window or observation opening in the housing of a machine to enable him or her effectively to operate the machine in normal conditions. Where it is necessary to operate the machine in special circumstances it may be necessary or desirable for the observer to have a different field of view from that normally available from the observation position, which may be defined for example by a seat which necessarily therefore restricts the range of movement of the operator's head. Although in some circumstances it may possible for the operator to rise from the seat in order to observe from a different point of view, this is not always possible, and circumstances sometimes arise in which a machine operator is constrained to remain in the seated position to operate the machinery, and to estimate what control operations or actions should be made in order to work the machinery on the basis of estimates made by the operator as to the control movements required to achieve a desired objective.

Such a situation arises, for example when using excavating machinery comprising a bucket or claw carried at the end of an articulated arm on a body or cabin turnable about a vertical axis. The range of movement of the articulated arm can position the bucket at locations which are not visible to the machine operator when seated at the controls in view of the necessarily limited size of the window through which the operator can observe the working of the bucket. Other, similar, situations arise with other forms of machinery involving moving parts, and with locomotive machinery when manoeuvring in confined spaces.

One attempt to solve this problem has been made, in the case of motor vehicles such as vans and motor caravans having very upright rear windows, to assist in reversing the vehicle, by positioning a fresnel refractor on the rear window to divert light arriving from a range of positions closely behind the rear of the vehicle towards the driver. Thus, when reversing, the driver can obtain a view, albeit somewhat distorted, of the region immediately to the rear of the vehicle, a view which would not otherwise be available due to the small size of the rear window, the opacity of the surrounding walls and the distance from the driver's eyes to the rear window.

Such a solution is not applicable in all circumstances where a restricted view may be a problem, however, because the presence of the light-diverting refractor obstructs the normal view through that part of the window or opening occupied by it. This, in turn, limits the size to which such refractors can be usefully made as it is essential to keep a substantial part of the window or opening for the normal direct view as well as to allow the diverted view.

The present invention seeks to provide a solution to this problem which is capable of enlarging the field of view of an observer through an opening to extend to areas which would otherwise be obscured.

According to one aspect of the present invention, therefore, there is provided an optical system for extending the field of view of an observer through an opening, comprising a light diverting element or system mounted to or adjacent the opening such that an image observed by an observer through the component is upright.

The present invention may also be considered to comprise an optical device for extending the field of view of an observer through an opening, comprising an optical component positioned or positionable between the observer and the opening and operable to divert by refraction light transmitted therethrough and to compensate for chromatic aberration introduced upon refraction such that light incident thereon from an angle which would not reach the observer can be diverted towards the observer without substantial degradation of the image thus viewed.

In such a system the said light diverting element or system may comprise or include a refractor carried by a mounting so as to be pivotable about an axis transverse the direction of light arriving at an observer at the said predetermined location from the said field of view whereby to be movable between an operative position to be viewed by an observer, and an inoperative position where it does not obstruct the field of view of the observer through the opening. It is preferred that the said axis is located

transversely of the said refractor, that is generally parallel to, and, preferably along (or spaced from) one edge of the refractor.

Preferably the refractor is a fresnel refractor, that is one comprising a plurality of elementary refracting surfaces in an array defining a general plane of the refractor.

One of the problems encountered when using refractors for light-diverting purposes arises from the chromatic aberrations, which are introduced upon refraction. Such aberrations can be compensated, however, according to this aspect of the invention, by the provision of a composite refractor comprising a plurality of refracting elements oppositely orientated with respect to their light-diverting action. An optical system in which the refractor comprises two fresnel refractors is particularly convenient although three or more refractor elements in an array may be provided.

In another aspect of the invention, there is provided an optical device for extending the field of view of an observer through an opening, comprising a first light-diverting optical component acting to divert light incident thereon through the opening at an angle greater than a critical angle of incidence and to transmit therethrough undeviated light incident thereon through the opening at an angle less than the critical angle, and a second light diverting component acting to divert the diverted light from the first component towards the observer.

In an embodiment of the invention in this aspect the light-diverter system may comprise a composite reflector system having an even number of reflectors.

A first reflector of such a reflector system may comprise a plurality of reflector elements in an array, with each element of the array being orientated transversely with respect to the general plane of the array. Such an array may be of the type generally described in the applicant's earlier British Patent No. 255 945. The disclosure of which is incorporated herein by reference.

In a reflector embodiment the second reflector may be pivotally mounted to or adjacent one edge of the said first reflector and, as in the refractor embodiment the reflectors are preferably generally planar in form and mounted in such a way that they can be folded parallel to one another and out of the line of sight of an observer to allow the normal field of view through the opening to be unobstructed when the light-diverter is not deployed.

The present invention also comprehends an optical system for diverting light to an observer from an obscured location, comprising first and second reflective units pivotally connected together for adjustment of their relative inclination, one of the reflective units comprising a plurality of reflective elements in an array extending parallel to the general plane of the said one reflective unit such that light incident on the said one unit is diverted by reflection as it passes through the unit.

In any of the above aspects or embodiments of the invention the reflectors or refractor elements may be convexely or concavely curved.

Conveniently, the mounting assembly may be such that the relative positions of the first and second reflector are adjustable to obtain a field of view therefrom in different directions in dependence on the relative position of the two elements.

Various embodiments of the present invention will now be more particularly described by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side view of a first embodiment of the invention;

Figure 1A is an enlarged side view of the light diverter system of Figure 1;

Figure 2 is a schematic side view of a composite refractor suitable to form part of the embodiment of Figure 1;

Figure 3 is a similar schematic side view of a tripartite composite refractor suitable to form part of an alternative version of the embodiment of Figure 1;

Figure 4 is a side view of a second embodiment of the invention in position in a cabin of a vehicle or machine;

Figure 4A is an enlarged side view of the embodiment of Figure 4:

Figure 5 is a side view of an alternative embodiment of the invention in an operative position:

Figure 5A is a side view of the embodiment of Figure 5 in a stowed or "parked" configuration.

Figure 6 is a side view of an alternative embodiment of the invention utilising reflectors shown in a deployed or operative position;

Figure 6A is a side view of the embodiment of Figure 4 in a parked or stowed position;

Figure 7 is a side view of a further embodiment of the invention incorporated into a structure;

Figure 8 is a side view of a further alternative embodiment of the invention positioned adjacent an opening in a machine or vehicle;

Figure 9 is an alternative diagrammatic illustration of a further alternative embodiment suitable for a machine or a vehicle; and

Figure 10 is a further schematic diagram illustrating another alternative embodiment of the invention.

Referring now to the drawings, Figure 1 illustrates a first embodiment of the invention adapted for use in an aircraft such as a sailplane or glider generally indicated 11. In Figure 1 only the front upper portion 12 of the aircraft is illustrated, together with the transparent canopy 13. It is known that, particularly when landing, the view forwardly and downwardly in such an aircraft is of critical importance. An enlarged field of view is provided by fitting a light diverting optical component 14 to the roof just behind the transparent canopy. This, as can be seen from Figure 1A comprises a composite fresnel prism structure which may be called a multi element fresnel prism refractor (MEFPR) 14 pivotally connected by a pivot 15 parallel to one edge horizontally and transversely across the canopy 13 so as to be perpendicular to the line of sight of a pilot as indicated by the arrows 16. The MEFPR 14 can thus be turned between a use position, as shown in Figure 1, and a stowed or parked position either forwardly against the canopy 13 or rearwardly against the roof 12. Between these two end positions, the MEFPR may be turned to any position to allow the user to select the precise field of view, that is so that the area of MEFPR is filled with light

from the direction of interest.

In the position as shown in Figure 1, the light-diverting optical component 14, in the deployed position, acts to refract light arriving from a forward region below the field of view of the pilot, represented by the ray traces A and B, thereby allowing a view below the nose of the aircraft immediately ahead of it to be obtained from the restricted position of the pilot strapped in the aircraft. Shades or louvres 17 (see Figure 1A) protect against stray light effects and also ensure that the refractor is not working when mounted to its stowed or parked position.

The refractor is a composite fresnel refractor unit the refractor 20 of which comprises two elements as illustrated in more detail in Figure 2. It will be appreciated that Figure 2 illustrates only a very small part of the fresnel refractor 20, with only two or three elementary prisms of each of two refractor sheets 22, 23 being shown. In practice there would be many more elementary prisms across the width of the element as a whole.

Each of the refractors 22, 23 which form part of the composite refractor 20 is made of an optically transparent material. Different materials are used for each refractor, in particular materials having different refractive indices from each other. The refractor 22 has a plane face 24 and an opposite face having a plurality of inclined elementary surfaces 25 separated by "risers" 26 to form a plurality of adjacent elementary prisms generally indicated 27, 28. The refractor element 23, likewise, has a plane face 29, and an opposite face in the form of a plurality of individual

elementary surfaces 30, 31 separated by "risers" 32 to define elementary prisms 33, 34. In general, a composite refractor suitable for this purpose comprises at least two optical elements of different material from one another positioned with their prismatic apex angles oriented oppositely from one another as illustrated in Figure 2. A preferred material for the element 23 is polymethylmethacrylate (PMMA) whilst a preferred material for element 24 is polycarbonate (PC). The inclination of the elementary surfaces 31, 30 to the plane surface 29 in the element 23, together with the choice of refractive index of the material from which the element 23 is made, cause it to introduce an opposite chromatic dispersion from that introduced by the element 24 as light is transmitted through it. As a result the light arriving at an observer's eye O provides an upright image which is not degraded by chromatic aberrations. The dimensions of the elementary surfaces 25, 31, 30 are typically of the order of 1mm and flat sheets of fresnel refractor may be produced using so-called micro-replication techniques employing thermoplastic material such as PMMA or PC using nanometre precision tooling produced by single point diamond machining. The elements 23, 24 may be assembled by bonding together using a transparent adhesive. Although shown as a flat sheet 20 in Figure 1 the composite refractor may, of course, be curved in one or more directions to enlarge or reduce the field of view. Likewise the elementary surfaces 31,32,33 or the corresponding surfaces on the other refractor may be convexly or concavely curved whereby to obtain magnification or reduction of the field of view as appropriate.

Figure 3 illustrates an alternative composite refractor in which there are three fresnel refractors rather than the two illustrated in Figure 2. In this embodiment the refractor

23 has been replaced by two thinner refractors 35, 36 each having inclined elementary surfaces defining prism apex angles in the same direction, both being in the opposite direction from that of the apex angles of the refractor 24. This construction allows a shorter path length for the refracted light through each of the optical elements 35, 36 than through the optical element 23 of Figure 2, thereby obtaining improved optical properties. This configuration also allows the elements 24,36 to be made exactly the same shape so that they can be fitted together and bonded by a transparent adhesive. The element 35 cannot be bonded in this way because the voids between the inclined surfaces and the flat face of element 36 must remain filled with air in order to achieve the desired result, and any adhesive present in these voids would degrade the performance of the component. In an alternative configuration (not shown) the element 35 may be reversed, so that its flat face is in contact with the flat face of element 36, in which case it can be bonded thereto by transparent adhesive. This, however has the disadvantage that the ribbed face of element 35 faces outwardly and this makes it more difficult to keep clean and dust free. As a further possible alternative configuration the element 35 may be placed, in the same orientation, on the other side of the pair of elements 24,36, that is against element 24. This, too, would result in the juxtaposition of two flat faces, simplifying bonding, but with the disadvantages mentioned above in relation to ribbed outer faces.

Figure 4 illustrates an alternative embodiment of the invention comprising a light-diverter assembly generally indicated 37 composed of two separate reflectors 38, 39 pivotally connected together along a common parallel edge by a pivotable connection 40 and one of which, the reflector 38, is pivotally mounted at 41 to the roof 12 of the

enclosure adjacent the upper edge of the opening 13.

In this embodiment the reflector 38 may a multiple refractor array as described in relation to Figures 2 or 3 or alternatively a stacked elementary reflector array of the type described in the applicant's earlier British Patent 2 255 945, namely one in which the reflective surfaces are formed as parallel elementary surfaces extending traversely with respect to the general plane of the element itself. This may be achieved by stacking together an array of sheets of transparent material and then cutting through the array perpendicular to the faces of the elements to provide cut sheets with a plurality of parallel interfaces or, alternatively, by bringing together two elements having parallel grooves or other indentations which, in the composite element define a plurality of reflective facets which are offset from one another parallel to the general place of the array.

The reflector array 38 is pivotally mounted at a proximal edge by a pivot 41 to the roof 12, and by a pivot 40 at its distal edge to a plane reflector 39. The pivotable connections 40, 41 allow the two reflectors 38, 39 to be extended to the deployed position illustrated in Figure 4 or two a folded or "parked" position (also illustrated in Figure 4A) in which both lie substantially parallel to one another and to the roof line 12 and out of the direct line of sight of the operator opening 13.

As can be seen in the inset to Figure 4A the stacked elemental refractor reflector array 38 comprises two transparent sheets 40, 41 each having a plane face 42,43 and an opposite ribbed face having asymmetric parallel grooves separated by

correspondingly shaped ribs which, when placed together with the ribs and grooves interpenetrating one another as shown in Figure 4A, define a plurality of air gaps or pockets 44 between alternate faces of the ribs or grooves, the other alternate faces being in contact with one another. This structure defines a plurality of interfaces acting as perfect reflectors by total internal reflection which reflect light incident thereon without dispersion so that no chromatic aberration takes place. Moreover, as can be seen in Figure 4, in the deployed position the deflector array 38 offers no diversion of light arriving generally perpendicular to the plane of the element 38 (that is parallel to the planes defined by the air pockets 44) so that the operator's view through the opening 13 in that direction is not impaired. By having two reflectors the image is upright.

Figure 4 also shows the device in its parked position and the lines of sight from an operator O through the opening 13 in the machine cabin (represented by the line L1) which represents the lowest view through the opening 13, and the lines L2 and L3 which show, respectively, the lowest view through the opening 13 by observing the reflector device 38 and a typical ray. Thus, when used in machinery such as cranes or excavators which may from time to time require the operator to have visibility outside the range afforded by the opening in the cabin in which the operator is located, this can be achieved by deploying the deflector device of the invention.

Figure 5 illustrates the device of the invention in an alternative configuration in which the plane reflector 39 is pivotally connected at 41 to an upper edge of an opening 13 whilst the stacked elemental reflector refractor array 38 is pivotally connected to the

plane reflector 39 at the pivot 40. This allows a more compact folding or parking configuration as illustrated in Figure 5A and is particularly suitable for use at the rear of a vehicle such as a truck or van. Automatic deployment of the device can be arranged when reverse gear is engaged. As in the embodiments described hereinbefore, the plane mirror 39 may be a flat plane mirror or may be concave or convex to vary the magnification of the image. Likewise the shapes of the facets in the two interpenetrating prism arrays may be curved or flat as shown.

Figure 6 illustrates an alternative embodiment, similar to that of Figure 5, but in which a plane reflector is formed in the undersurface of a rear spoiler 45 projecting rearwardly from the roofline 12 over the opening 13. In this embodiment the stacked elemental reflector refractor array 38 is directly pivotally connected to the upper edge of the opening 13 at a pivot 46 so that it can turn between the deployed position illustrated in Figure 6 and the parked position illustrated in Figure 6A.

Of course, it is not necessary for one of the reflector elements to be a plane reflector, and both may be formed as stacked elemental reflector refractor arrays. Figure 7 illustrates such an embodiment in which an upper portion 47 of the glazing in the opening 13 is formed as a stacked elemental reflector refractor array and a second such array 48 is pivotally connected at 49 to the roof 12 of the vehicle for movement between the deployed position (illustrated in solid outline) and the parked position (illustrated in broken outline). When the pivoted array 48 is in the parked position the operator O can see straight through the fixed array 47 since light is only reflected at incident angles greater than a predetermined angle of incidence.

Figures 8, 9 and 10 illustrate embodiments suitable for use at the front of a coach or heavy goods vehicle the windscreen 50 of which extends to a position such that a region represented by the letter A in front of the vehicle is obscured by the vehicle's nose. This is represented by the line of sight B from the eyes of the driver D to the ground. A light diverting device formed as an embodiment of the invention, and again comprising a stacked elemental reflector refractor array 38 pivotally connected to a mount 51, and a plane mirror 39 fixedly connected to the mount 51 allow the diversion of light from a region close to the front of the vehicle to reach the driver's eyes.

Figure 9 illustrates a configuration in which a mirror 39 is pivotally connected to the windscreen 50 at a point above the mount 51 and the stacked elemental reflector refractor array 38 pivotally connected to it. This configuration has the advantage of allowing a view slightly closer to the front of the vehicle than that obtained by the embodiment of Figure 8, and can be stacked or parked in a slightly more compact configuration.

In the embodiment of Figure 10 there are two independent stacked elemental reflector refractor arrays, a first 51 being incorporated into the lower part of the windscreen 50 and a second 38 being pivotally mounted on the mount 51 in an adjustable manner. This, again, is a particularly compact configuration and obtains a field of view similar to that of the embodiment of Figure 9.

CLAIMS

1. An optical system for extending the field of view of an observer through an opening, comprising a light diverting element or system mounted to or adjacent the opening such that an image observed by an observer through the component is upright.

2. An optical device for extending the field of view of an observer through an opening, comprising an optical component positioned or positionable between the observer and the opening and operable to divert by refraction light transmitted therethrough and to compensate for chromatic aberration introduced upon refraction such that light incident thereon from an angle which would not make the difference can be diverted towards the observer without substantial degradation of the image thus viewed.

3. An optical system as claimed in Claim 1 or Claim 2, in which the said light diverting element or system comprises or includes a refractor carried by a mounting so as to be pivotable about an axis transverse the direction of light arriving at an observer at the said predetermined location from the said field of view whereby to be movable between an operative position to be viewed by an observer, and an inoperative position where it does not obstruct the field of view of the observer through the opening.

4. An optical system as clamed in Claim 3, in which the said axis is located transversely of the said refractor.

5. An optical system as claimed in Claim 2 or Claim 3, in which the refractor is a fresnel refractor.

6. An optical system as claimed in any of Claims 3 to 5, in which the refractor comprises a plurality of elements oppositely oriented with respect to their light diverting action whereby to compensate for chromatic aberration.

7. An optical system as claimed in Claim 5 in which the refractor comprises three elements.

8. An optical device for extending the field of view of an observer through an opening, comprising a first light-diverting optical component acting to divert light incident thereon through the opening at an angle greater than a critical angle of incidence and to transmit therethrough undeviated light incident thereon through the opening at an angle less than the critical angle, and a second light diverting component acting to divert the diverted light from the first component towards the observer.

9. An optical system as claimed in Claim 8, in which the light diverter element or system comprises a composite reflector system comprising an even number of reflectors.

10. An optical system as claimed in Claim 8 or Claim 9, in which a first reflector of the system comprises a plurality of reflector elements in an array with each element of the array oriented transversely with respect to the general plane of the array.

11. An optical system as claimed in any of Claim 8, 9 or 10, in which a second reflector is pivotally mounted to or adjacent one edge of the said first reflector.

12. An optical system as claimed in any of Claims 8 to 11, in which the relative position of the first and second reflectors are adjustable to obtain a field of view therefrom in different directions in dependence on the relative position of adjustment of the reflectors.

13. An optical system for diverting light to an observer from an obscured location, comprising first an second reflective units pivotally connected together for adjustment of their relative inclination, one of the reflective units comprising a plurality of reflective elements in an array extending parallel to the general plane of the said one reflective unit such that light incident on the said one unit is diverted by reflection as it passes through the unit.

14. An optical system as claimed in any preceding claim in which the reflectors or refractors are convexly or concavely curved.

15. A manoeuvring aid for a machine or a vehicle, comprising a light-diverting optical unit mounted or mountable on or within the vehicle in such a way that it can be moved between a first or storage position which does not obstruct the field of view through an opening in the vehicle and a second or operative position in the line of sight of the vehicle operator, whereby to provide the operator with a modified field of view through the said optical unit.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 April 2001 (19.04.2001)

PCT

(10) International Publication Number
WO 01/26930 A1

(51) International Patent Classification[7]: B60R 1/10

(21) International Application Number: PCT/GB00/03845

(22) International Filing Date: 9 October 2000 (09.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9923780.2 8 October 1999 (08.10.1999) GB

(71) Applicant *(for all designated States except US)*: FORD-WERKE AG [DE/DE]; Henry Ford Strasse 1, D-50725 Köln (DE).

(71) Applicant and
(72) Inventor: MILNER, Peter, James [GB/GB]; 100D Leicester Road, Hinckley, Leicestershire LE10 1LU (GB).

(74) Agent: BRYER, Kenneth, Robert; K R Bryer & Co., 7 Gay Street, Bath BA1 2PH (GB).

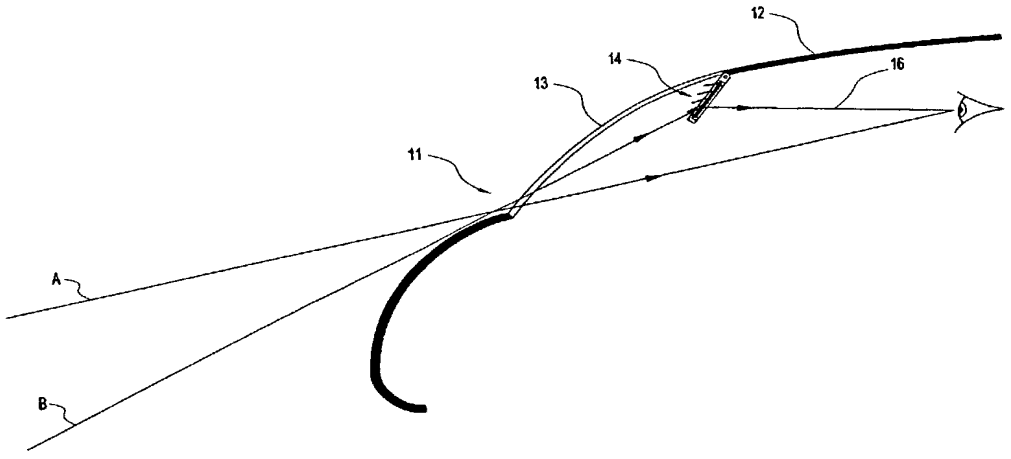
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: AN OPTICAL SYSTEM



(57) Abstract: An optical system for extending the field of view of an observer (0) through an opening (13), comprises a light diverting element or system mounted to or adjacent the opening (13) such that an image observed by an observer through the component is upright. The optical device comprises an optical component (14) positioned or positionable between the observer (0) and the opening and operable to divert by refraction light transmitted therethrough and to compensate for chromatic aberration introduced upon refraction such that light incident thereon from an angle which would not reach the observer can be diverted towards the observer without substantial degradation of the image thus viewed. Reflector only versions comprise a first reflector acting to reflect light incident thereon through the opening at an angle greater than a critical angle of incidence, and a second reflector acting to divert the light arriving from the first reflector towards the observer. Either or both reflectors may be of a type comprising a plurality of elemental reflectors in a stacked array.

WO 01/26930 A1

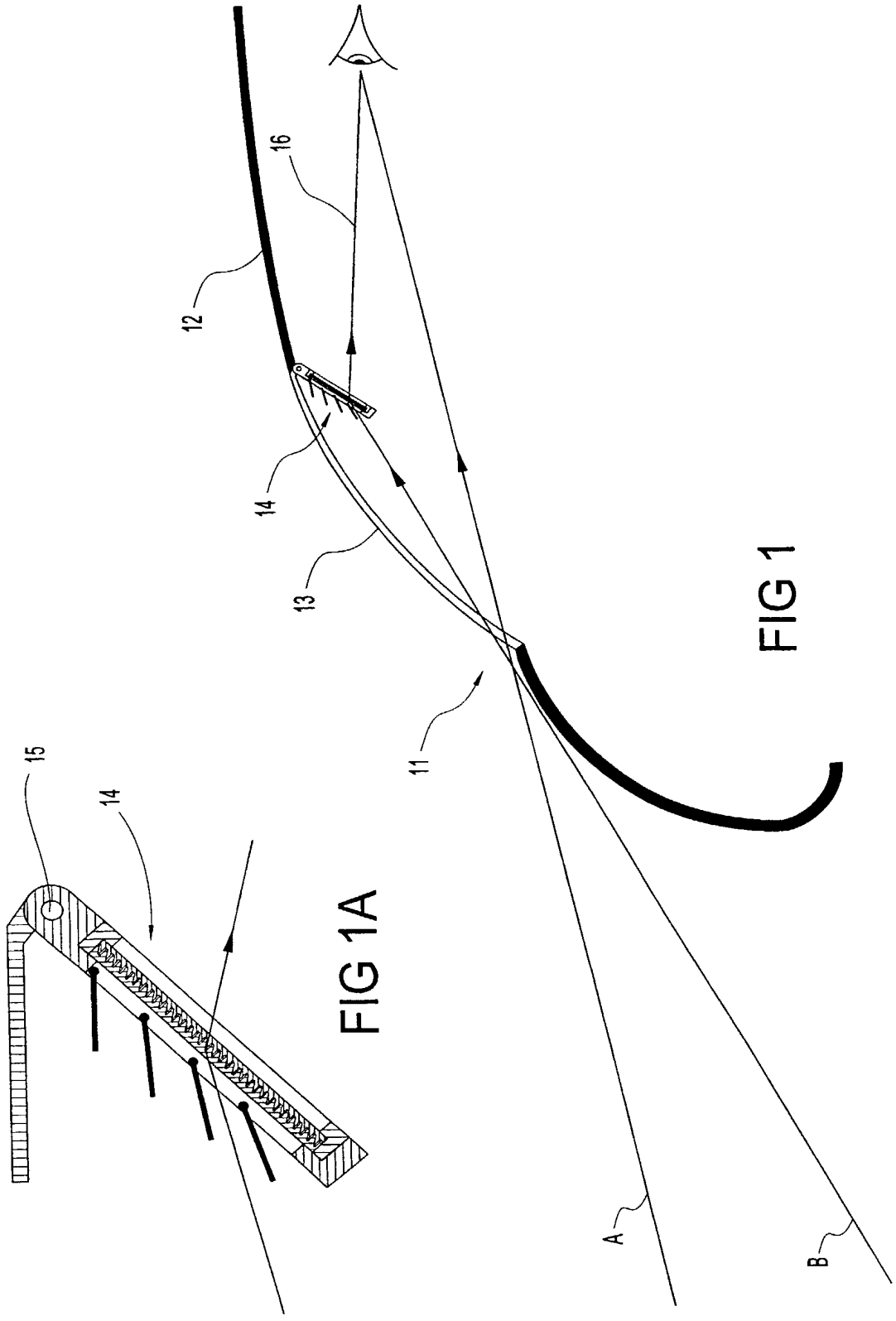


FIG 1

FIG 1A

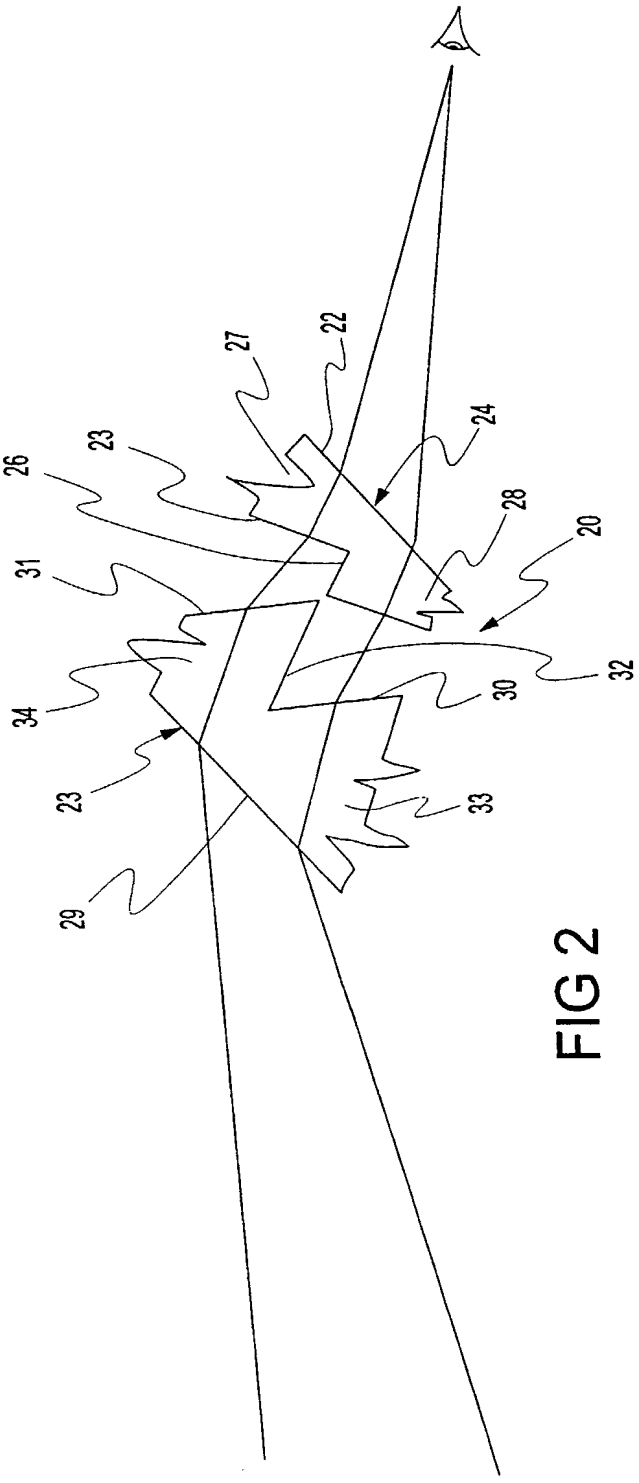


FIG 2

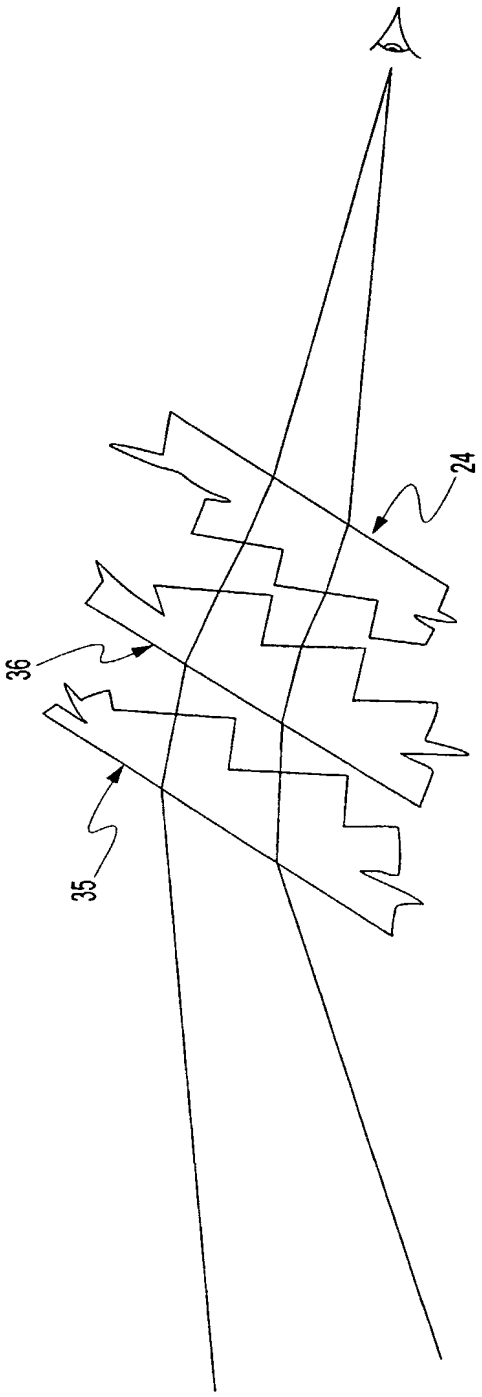


FIG 3

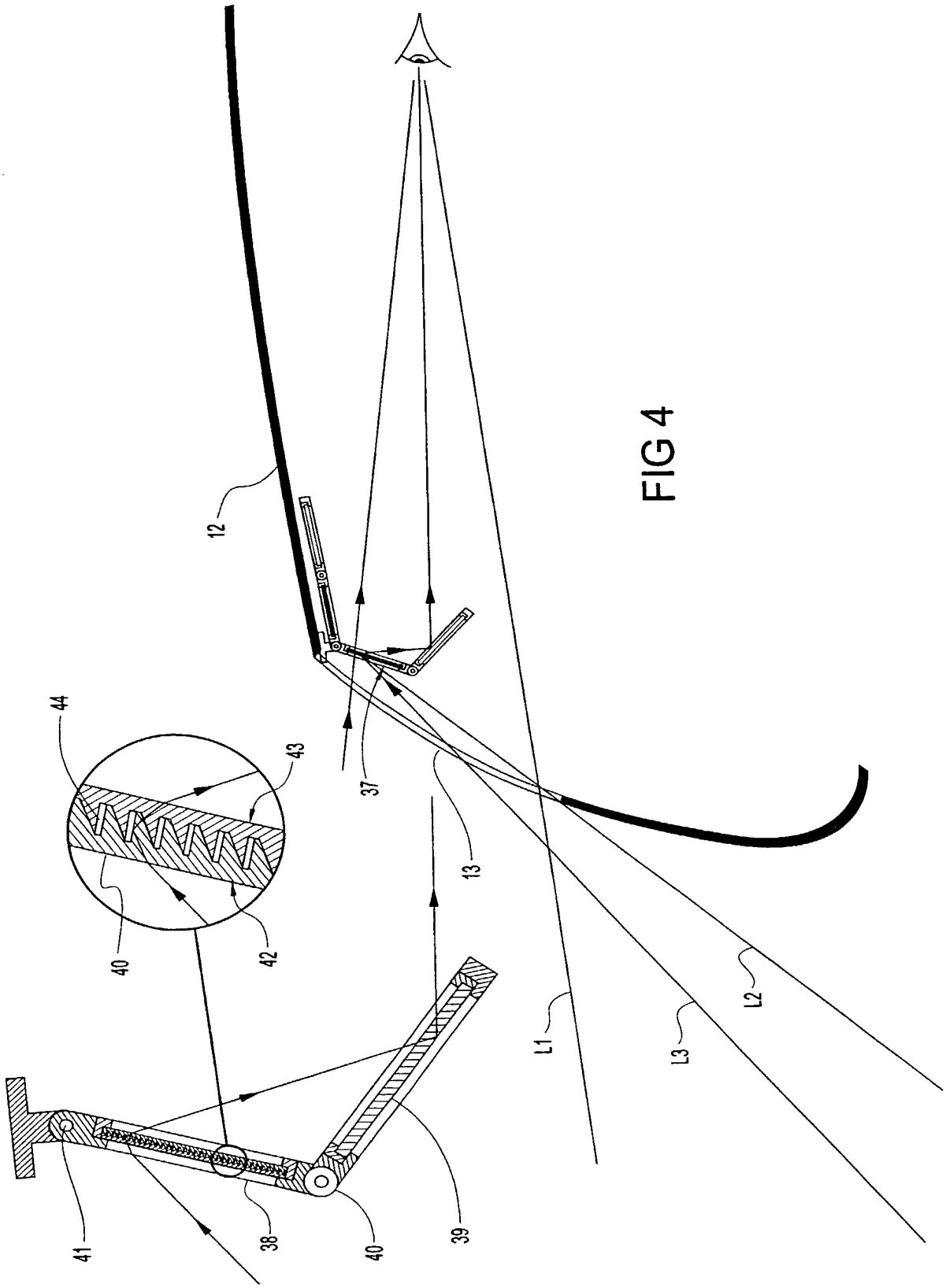


FIG 4

FIG 5A

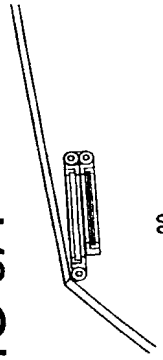
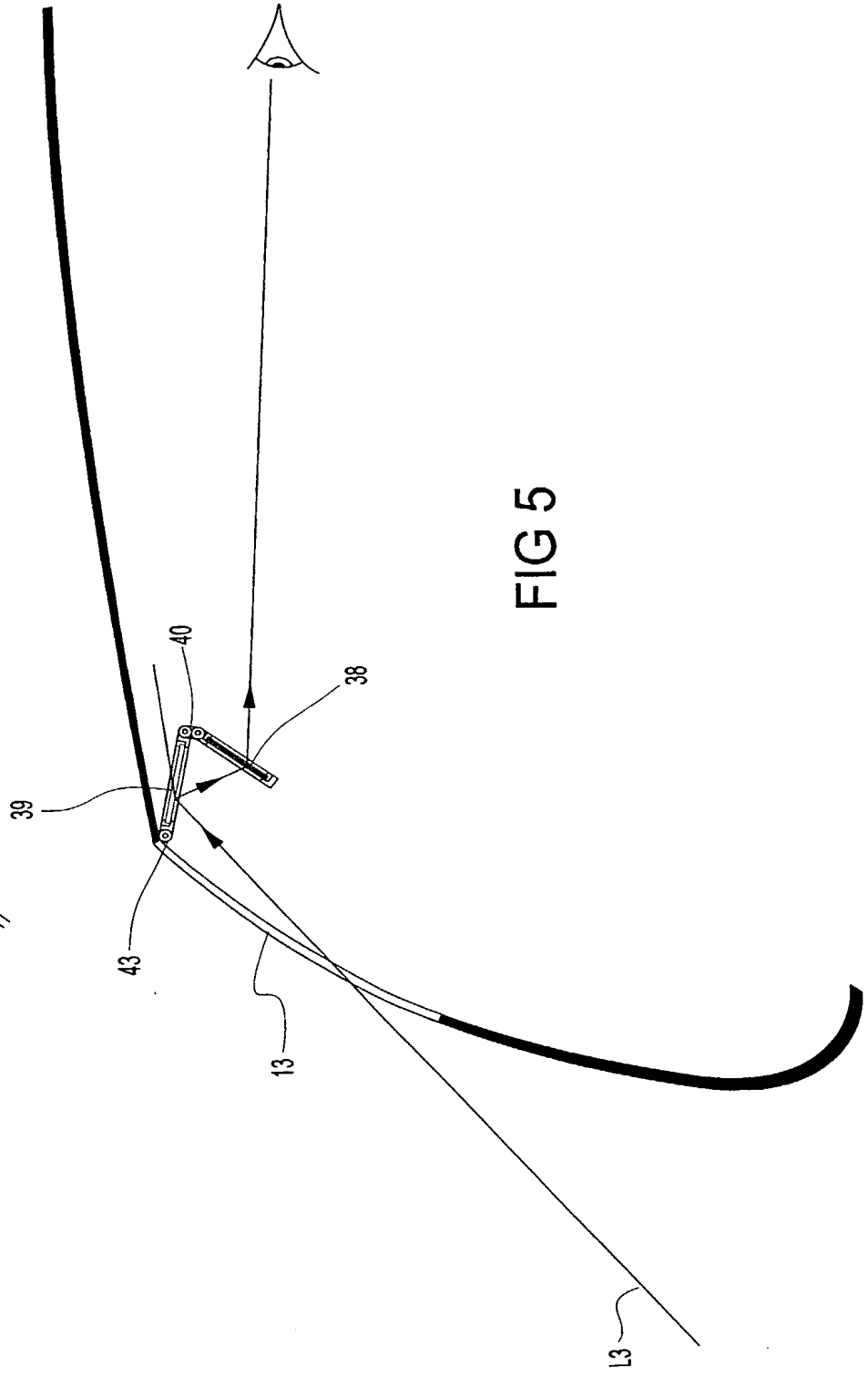


FIG 5



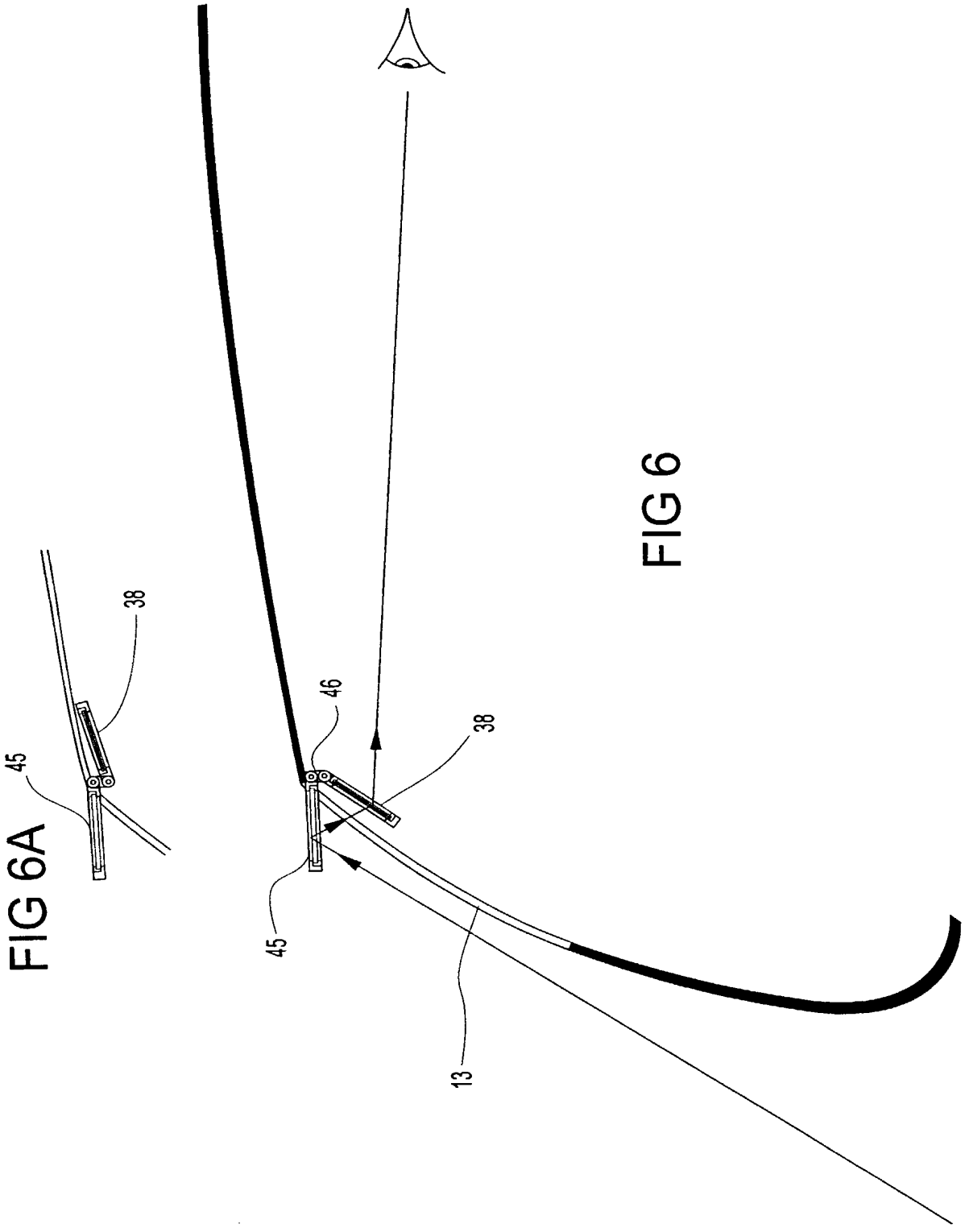


FIG 6A

FIG 6

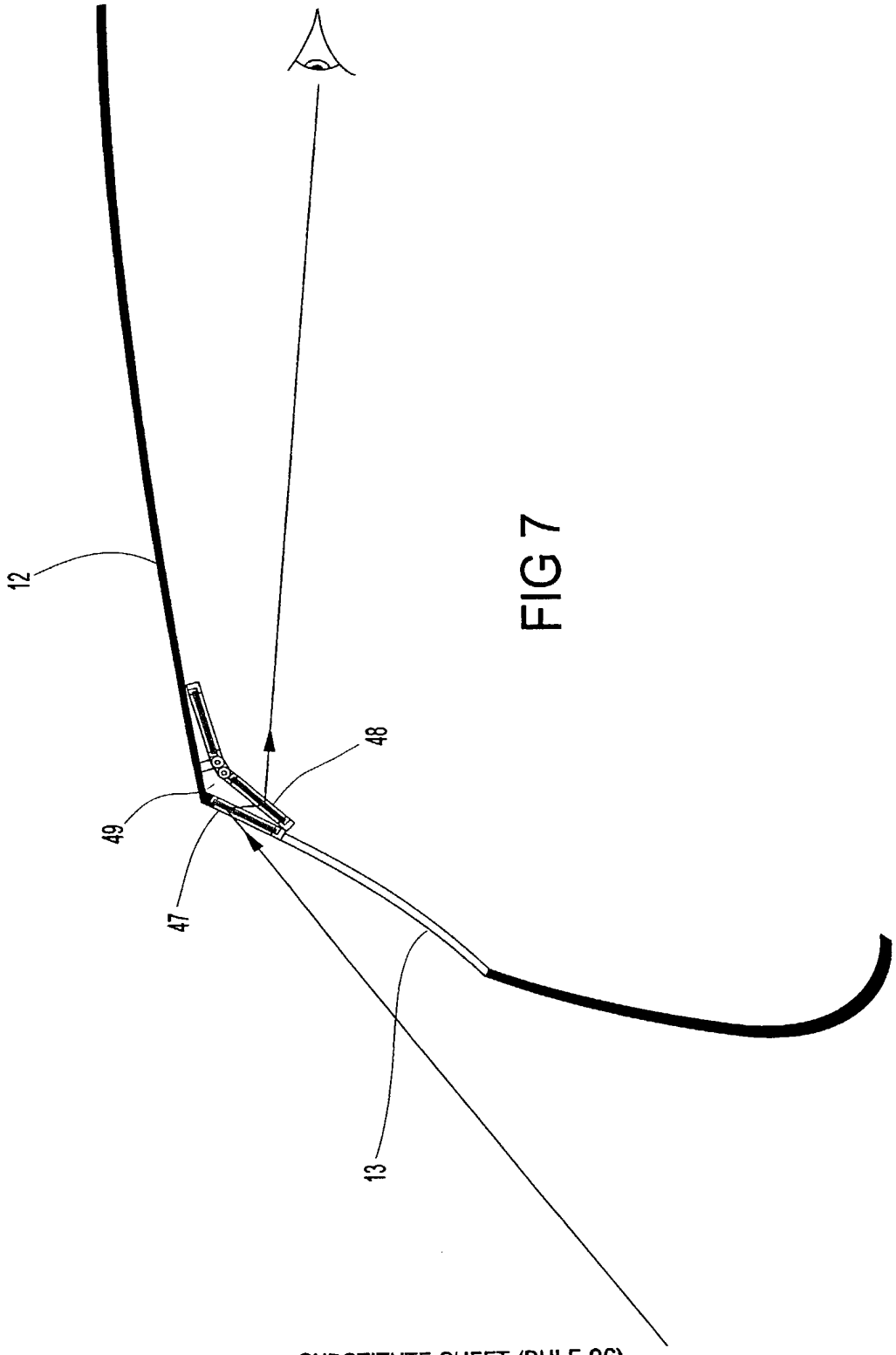


FIG 7

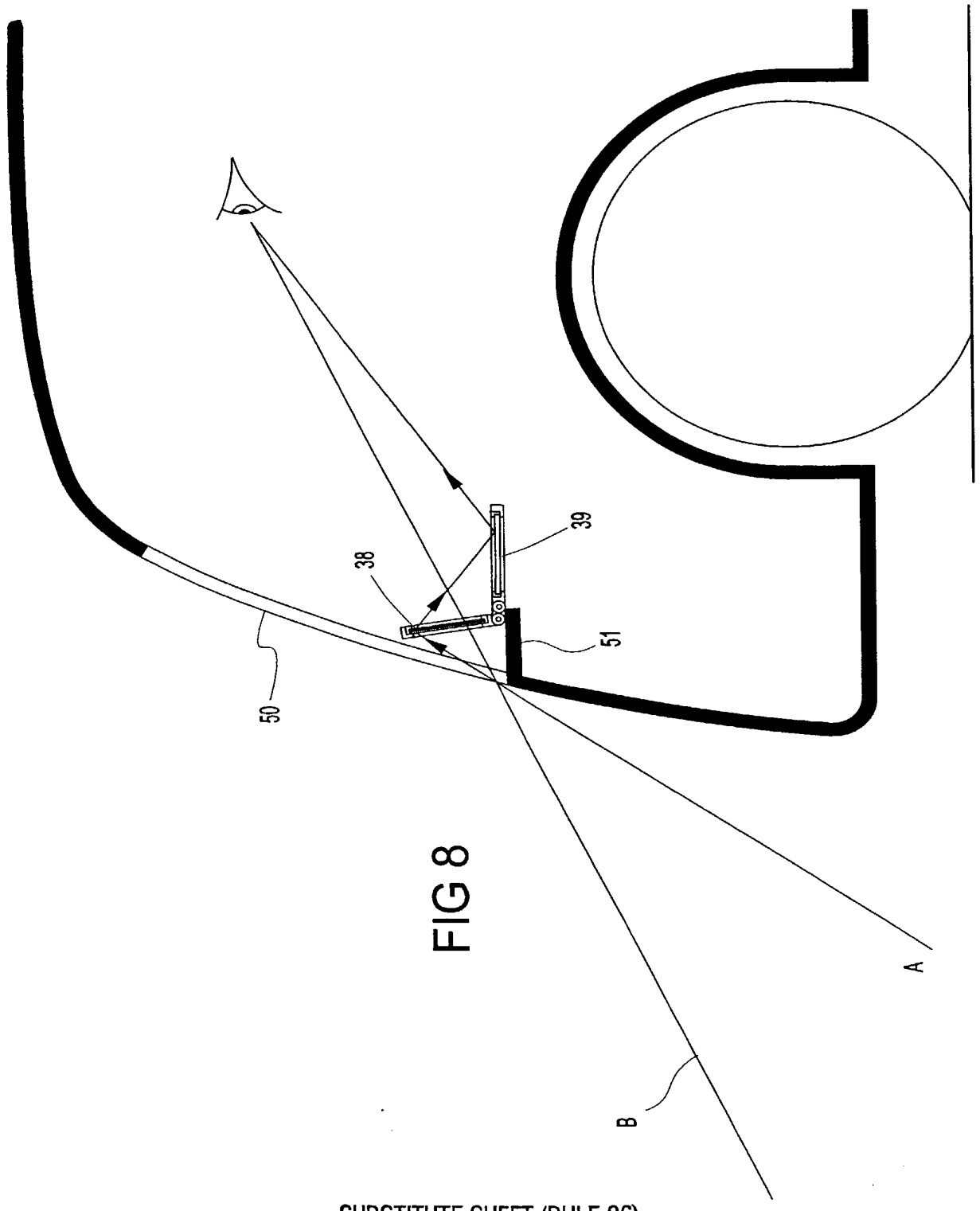


FIG 8

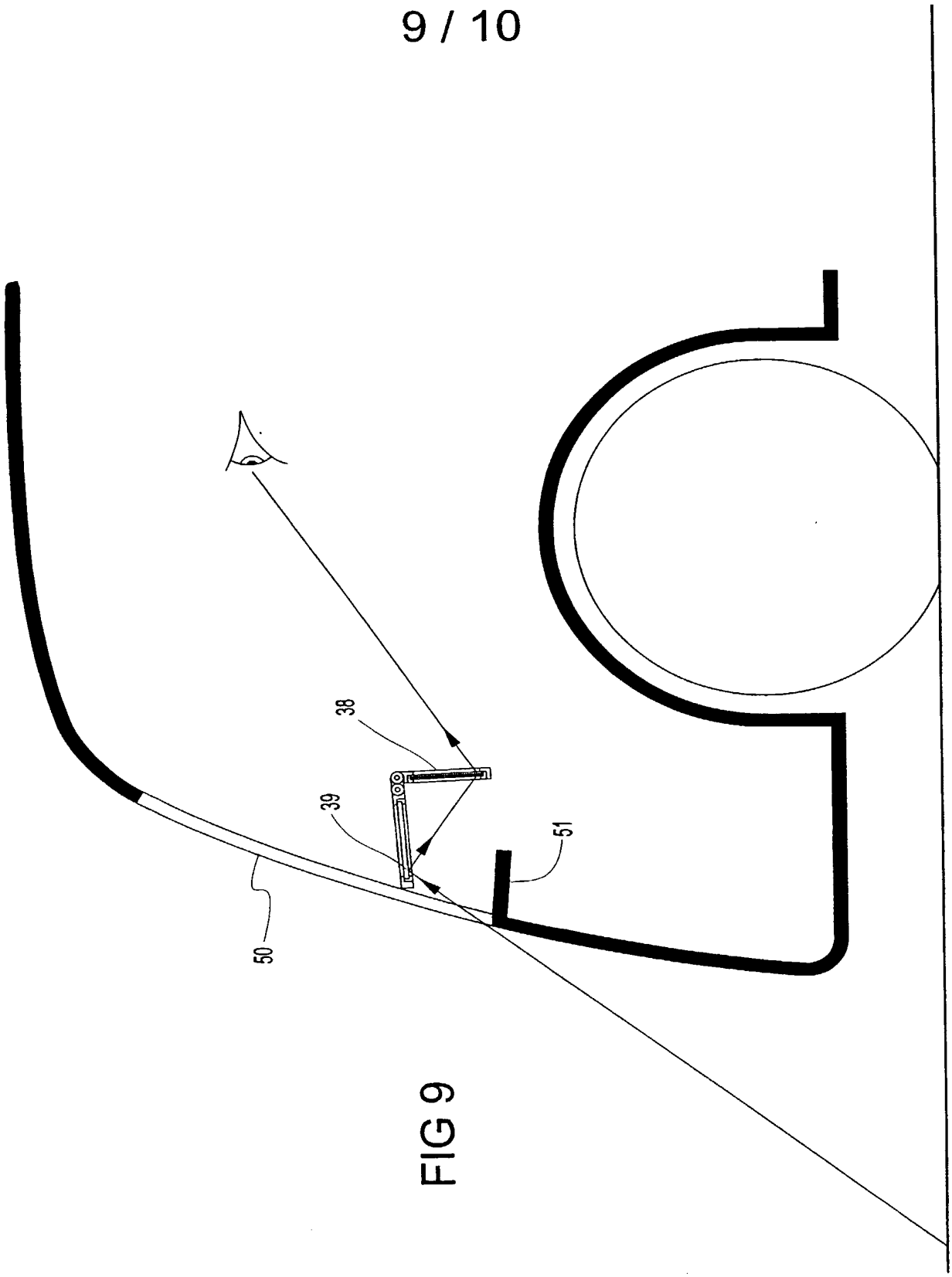


FIG 9

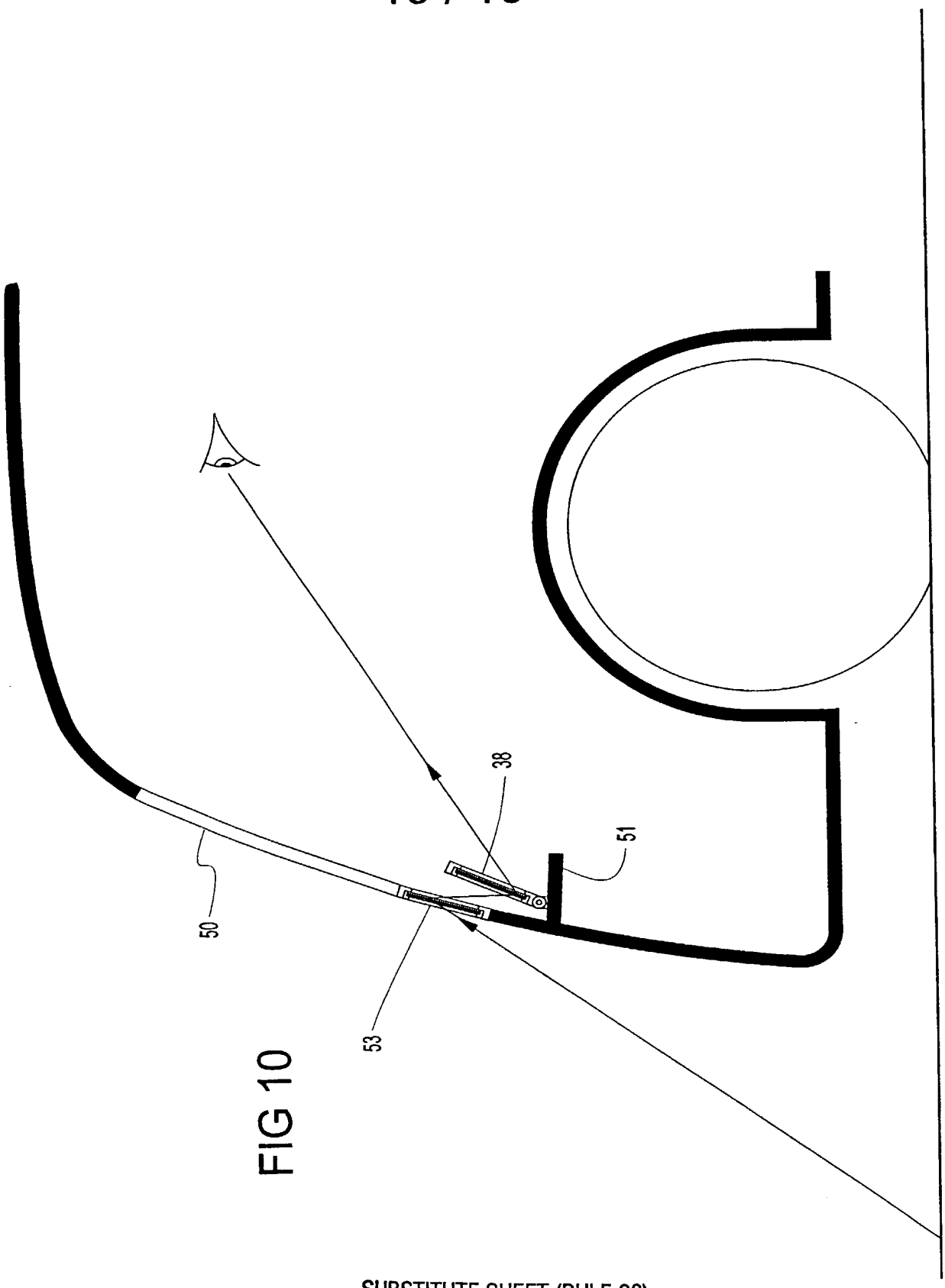


FIG 10

ATTORNEY DOCKET NO. BKR-22202/01

DECLARATION, POWER OF ATTORNEY AND PETITION

As the below named inventor, I hereby declare:

my residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled AN OPTICAL SYSTEM, the specification of which

[ ] is attached hereto.
[ ] was filed on_____,
as Application Serial No._____
and was amended on_____(if applicable).
[X] was described and claimed in PCT International Application No PCT/GB00/03845 and as amended under PCT Article 34 on 19 December 2001.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent & Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

PRIORITY CLAIM UNDER 35 USC § 119(a)-(d)

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or §365(b) of any foreign applications(s) for patent or inventor's certificate, or §365(a) of any PCT International Applications designating at least one country other than the U.S. listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT International Applications designating at least one country other than the U.S. having a filing date before that of the application on which priority is claimed:

[ ] no such applications have been filed
[X] application(s) listed below:

PRIOR FOREIGN APPLICATIONS
(Filed More Than Twelve Months (Six Months for Design) Prior To This Application

9923780.2	GB	8 October 1999
(Number)	(Country)	(Day/month/year filed)

POWER OF ATTORNEY

And I hereby appoint Ernest I. Gifford, P.O. Reg. 20,644; Allen M. Krass, P.O. Reg. No. 18,277; Irvin L. Groh, P.O. Reg. No. 17,505; Douglas W. Sprinkle, P.O. Reg. No. 27,394; Thomas E. Anderson, P.O. Reg. No. 31,318; Ronald W. Citkowski, P.O. Reg. No. 31,005; Judith M. Riley, P.O. Reg. No. 31,561; Douglas J. McEvoy, P.O. Reg. No. 34,385; Ellen S. Cogen, P.O. Reg. No. 38,109; Roberta J. Morris, P.O. Reg. No. 33,196; John G. Posa, P.O. Reg. No. 37,424; Douglas L. Wathen, P.O. Reg. No. 41,369; Avery N. Goldstein, P.O. Reg. No. 39,204; Mark D. Schneider, P.O. Reg. No. 43,906; and Beverly M. Bunting, P.O. Reg. No. 36,072, as my attorneys, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith. Send all correspondence to: Douglas W Sprinkle, 280 N. Old Woodward Avenue, Suite 400, Birmingham, Michigan 48009; Telephone (248) 647-6000.

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole inventor MILNER, Peter James

P J Milner

Inventor's signature

Date 15 April 2002 Citizenship Great Britain

Residence Great Britain GBN

Post Office Address 100D Leicester Road, Hinckley, Leicestershire LE10 1LU, Great Britain